

ALIMENTARY ORIGIN OF NYCOTHEMERAL VARIATIONS IN THE
ELECTRICAL ACTIVITY OF THE SMALL INTESTINE IN THE RAT

M. Ruckebusch and J. P. Ferre

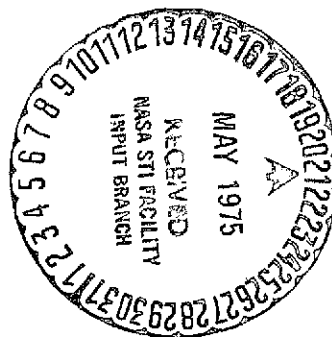
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16. Abstract Tests were performed on the alimentary origin of nyctothermal variations in the electrical activity of the jejunum in rats accustomed to an intermittent fast of 3 days per week. The role of gastric fullness seems to be critical in the presence of segmental activity in the rat.			
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The intestinal electromyography of the rat consists of /2005
slow waves with a high repetition frequency (30-36/min), of which
45% carry, in addition, bursts of potentials in the jejunal zone
in the subject fed ad libitum [1]. Each of the bursts is preceded
by a slow wave and consists of 3 to 20 potentials of amplitude
between 50 and 200 microvolts. The appearance of these bursts,
in an erratic manner, behind each of the slow waves constitutes
activity of a dispersed type. When each slow wave is systemati-
cally followed by a burst of potentials for 2 to 3 minutes, the
activity is termed segmental [3]. This type of activity is
propagated slowly (2 cm/min) along the entire length of the small
intestine in the rat. Its movement is comparable to a myoelectric
complex present in the dog during interdigestive periods [2]
and to an activity described in the sheep in which propagation
is independent of the rhythm of alimentary ingestion.

In the rat fed ad libitum, the segmental activity is present
during the diurnal phase of the nycthemeron (period of alimen-
tary rest) and it alternates with the activity of the dis-
persed type, seen at night (period of alimentary ingestion).
This work was concerned with the alimentary origin of nycthemeral
variations in electrical activity of the jejunum in rats accus-
tomed to an intermittent fast of 3 days per week [1] and placed

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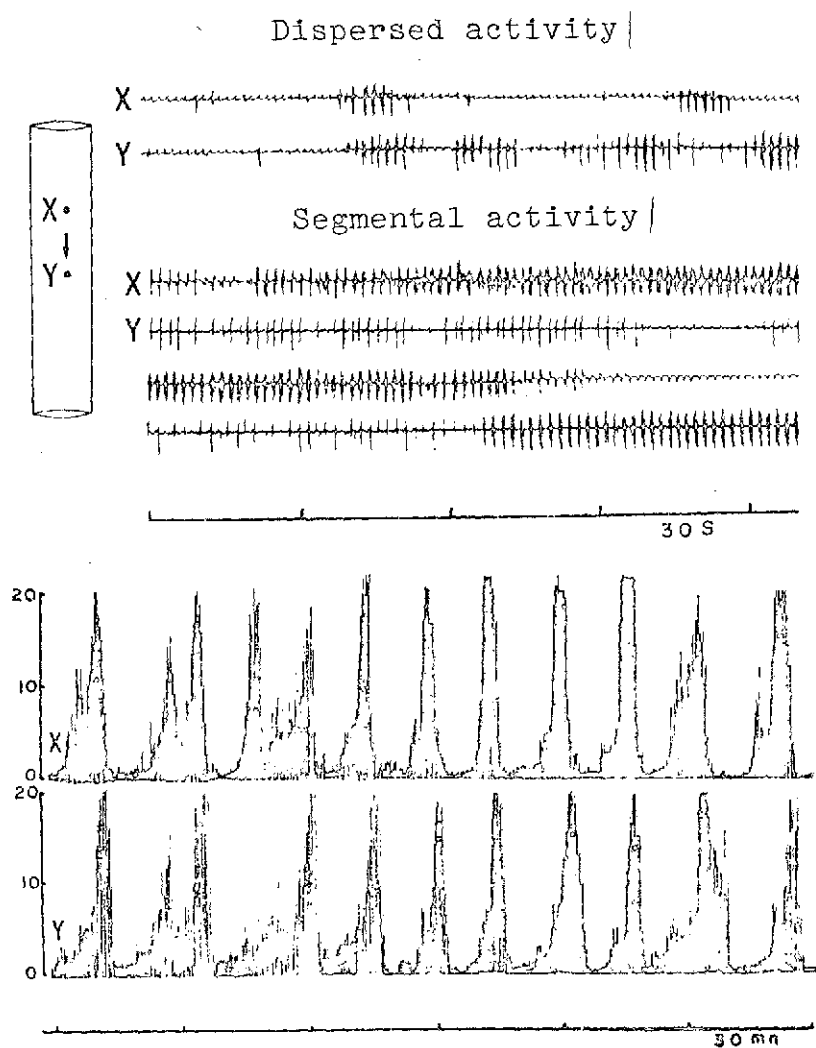


Figure 1. Electrical activity of the proximal jejunum taken from 2 points (X and Y) separated by 4 cm in the rat. The dispersed type of activity is constituted by the groups of 4 to 10 potential bursts. The segmental type activity constituted at X by about a hundred potential bursts recurs after about 2 minutes at Y. The summation of these signals over 3 hours and their value every 20 seconds, expressed in microcoulombs, indicates a recurrence of phases of segmental activity about every 18 minutes.

in a situation in which they were unable to reingest their droppings [4].

Experimental procedures

Male Wistar rats, 300 g, were isolated in transparent cages 15 cm in diameter and trained for two months under conditions of intermittent fasting. Intestinal electromyograms were obtained with bipolar recordings 24 hr/24 for 1 to 2 weeks from two groups of electrodes fixed at 4 cm intervals on the duodenum, the jejunum and the ileum, or only at the level of the jejunum. The jejunal electromyogram was integrated every 30 seconds on a potentiometric recorder [5] so as to obtain qualitative findings condensed temporally (speed of paper output 15 cm/hr). Figure 1 supplies an example of the quantification of the jejunal electromyogram.

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Electrical activity was examined at the level of the proximal jejunum; a) in subjects fed ad libitum (controls); b) in subjects during fasting periods, either supplied with a corselet and placed on a large mesh grill [4] or not protected and placed on a fine mesh grill; c) in fasting subjects furnished with a gastric fistula. The fistula was open, with the aim of subjecting the animal to a false meal (maintained on gastric emptiness). It also allowed the introduction into the stomach of an amount of food weighing about the same (6 to 8 gm) as a normal alimentary load (state of gastric satiation). Each of the experimental setups was replicated 10 to 15 times in groups of 10 subjects.

Results. The electromyogram of the control rats is characterized by an elevated frequency of slow waves (y), with a mean decline on the order of 15% over the 80 cm of small intestine length (x) ($y = 36 - 0.67 x$). During the nocturnal phase of the

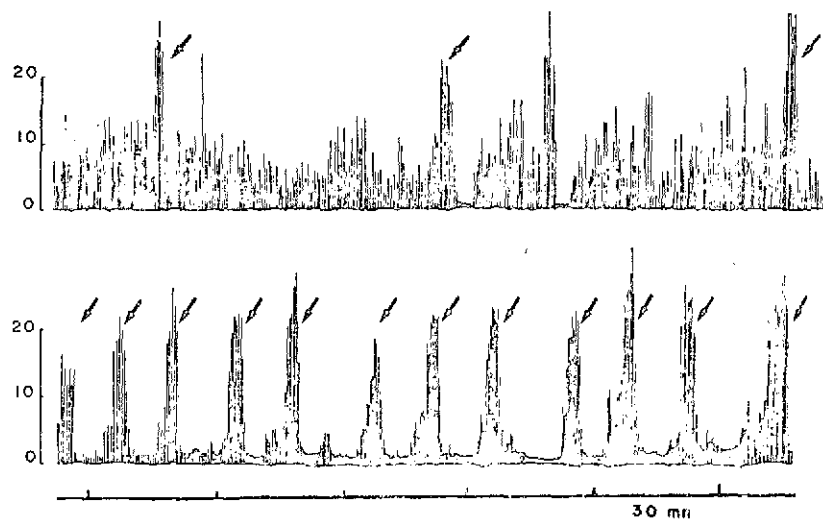


Figure 2. Integration of signals at a point on the jejunum in the control subject fed ad libitum. Above, activity essentially of the dispersed type during the nocturnal phase of the nycthemeron. Below, segmental type activity, indicated by the arrows, during the diurnal phase of the nycthemeron.

nycthemeron in rats fed ad libitum, i.e., during alimentary loads [6], approximately 60% of the slow waves have bursts of potentials superimposed and rapid activity of the dispersed type is the rule. On the other hand, during the day the percentage of slow waves with superimposed bursts is about 30 and segmental activity predominates (Figure 2).

The alternation of these two types of activity during the nycthemeron is related to the state of gastric fullness or emptiness observed under the following circumstances:

1. In the rat undergoing intermittent fasting without being able to exhibit coprophagia, the rapid activity involves about 30% of the slow waves and is always of the segmental type, from the 5th or 6th hour following the start of the diet (Figure 3).

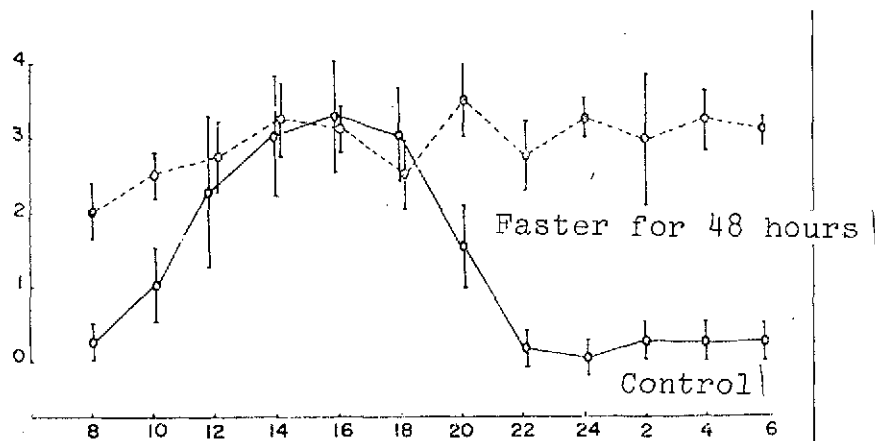


Figure 3. Nyctothermal distribution of the number of segmental activity bursts per hour in the rat fasting for 48 hours and prevented from displaying coprophagia (filled circles) and in the subject fed ad libitum (open circles).

2. On the other hand, in the rat undergoing intermittent fasting, without any precautions against coprophagia, which can involve 40% of the feces [7], an intestinal activity of the dispersed type persists during part of the first 24 hours. /2008

3. The false meal test, i.e., not followed by an accumulation of food in the stomach, does not modify detectably the motor profile of the intestine in subjects fasting for 48 hours. The number of activity phases of the segmental type remains between 2 and 3 per hour, with a slight tendency on occasion to accelerate for 1 hour.

4. On the other hand, the administration of a quantity of food by gastric cannula which has just been eaten by the animal, induces a disappearance of segmental activity in favor of a dispersed type activity for a period between 3 and 6 hours.

Discussion:

The study of electrical activity of the small intestine and, more particularly, of the jejunum shows that an elevated frequency of repetition of slow waves in the rat corresponds equally to an elevated recurrence of segmental activity.

When the subject is at alimentary rest, whether in the diurnal phase of the nycthemeron under ad libitum feeding conditions or during a period of intermittent fasting in the subject accustomed to food deprivation, the percentage of slow waves with superimposed potential bursts is about 30, and the rapid activity encountered is essentially of the segmental type. This persists in the presence of bucco-pharyngeal factors related to food intake.

The state of gastric fullness obtained by spontaneous eating or direct administration of food into the stomach, leads to an increase in the number of potential bursts which accompany 60% of the slow waves, in an apparently irregular manner. This dispersed type activity persists for several hours in the /2009 subject fed ad libitum, and during practically the entire nycthemeron in rats who, following a period of fasting, ingest in 4 hours an amount of food similar to that eaten by controls in a week [1].

In summary, the role of the state of gastric fullness appears to be critical in determining the presence of segmental activity in the rat.

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